Forage indicators and nutritional profiles for Chesapeake Bay fishes

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Outline

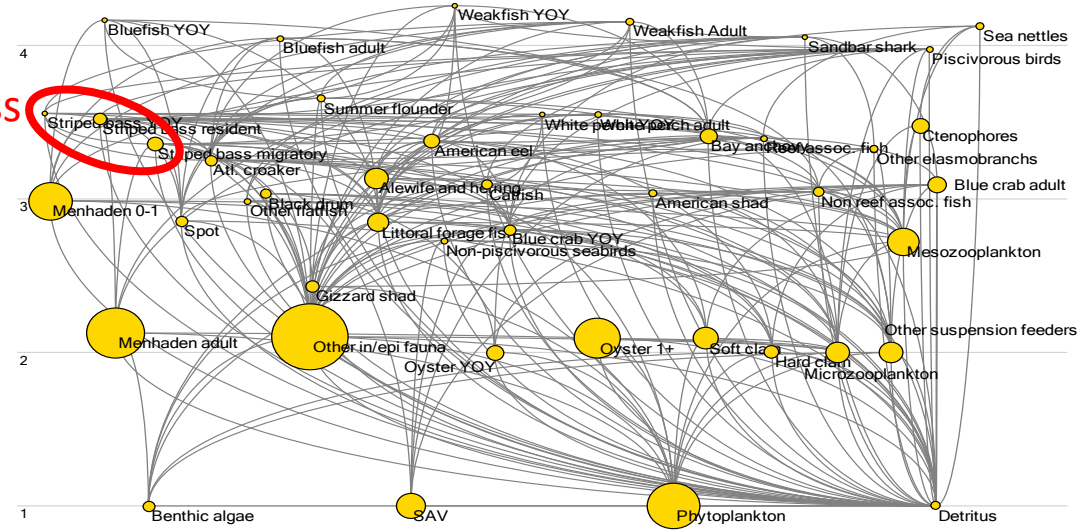
- Background
- Project Objectives
- Approach
  - Objective 1
  - Objective 2
- Expected Outcomes

Background

- Ecosystem approaches to fisheries management (EAFM)
  - Requires understanding of forage base and predator-prey interactions
  - Ongoing efforts in Chesapeake Bay and concerns over food supply to predators
- Forage species (fishes & invertebrates)
  - Support production of economically and ecologically valuable species
  - Most forage species are not managed directly
  - Complexity of Bay food web and EAFM is simplified by focusing on key forage

E.g.,
striped bass

Chesapeake Bay Food Web



Chesapeake Bay Fisheries Ecosystem Model (Christensen et al. 2009)

2014 CBP Watershed Agreement & Forage Workshop

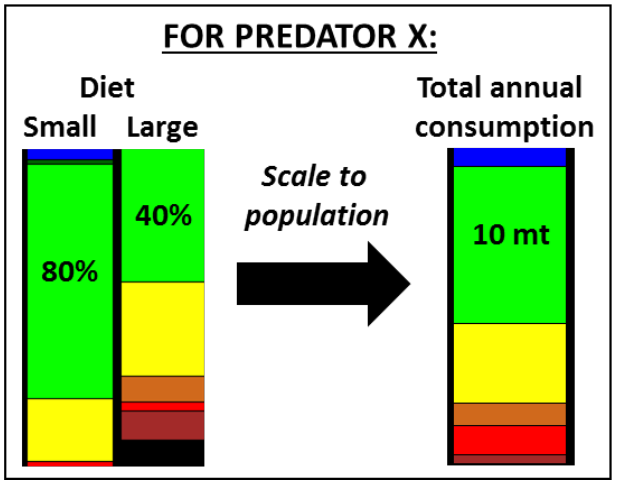
- Sustainable fisheries goal:
  - "Protect, restore and enhance finfish, shellfish and other living resources, their habitats and **ecological relationships** to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay."
- Forage fish outcome:
  - "By 2016, develop a strategy for assessing the forage fish base available as food for predatory species in the Chesapeake Bay."
- Forage Workshop, Nov 2014 (sponsored by STAC)
  - What are the key forage species (or groups) in the Bay?
  - How do we quantify and monitor the status of these groups?
  - How can such information be used in management decisions?

Ihde et al. 2015

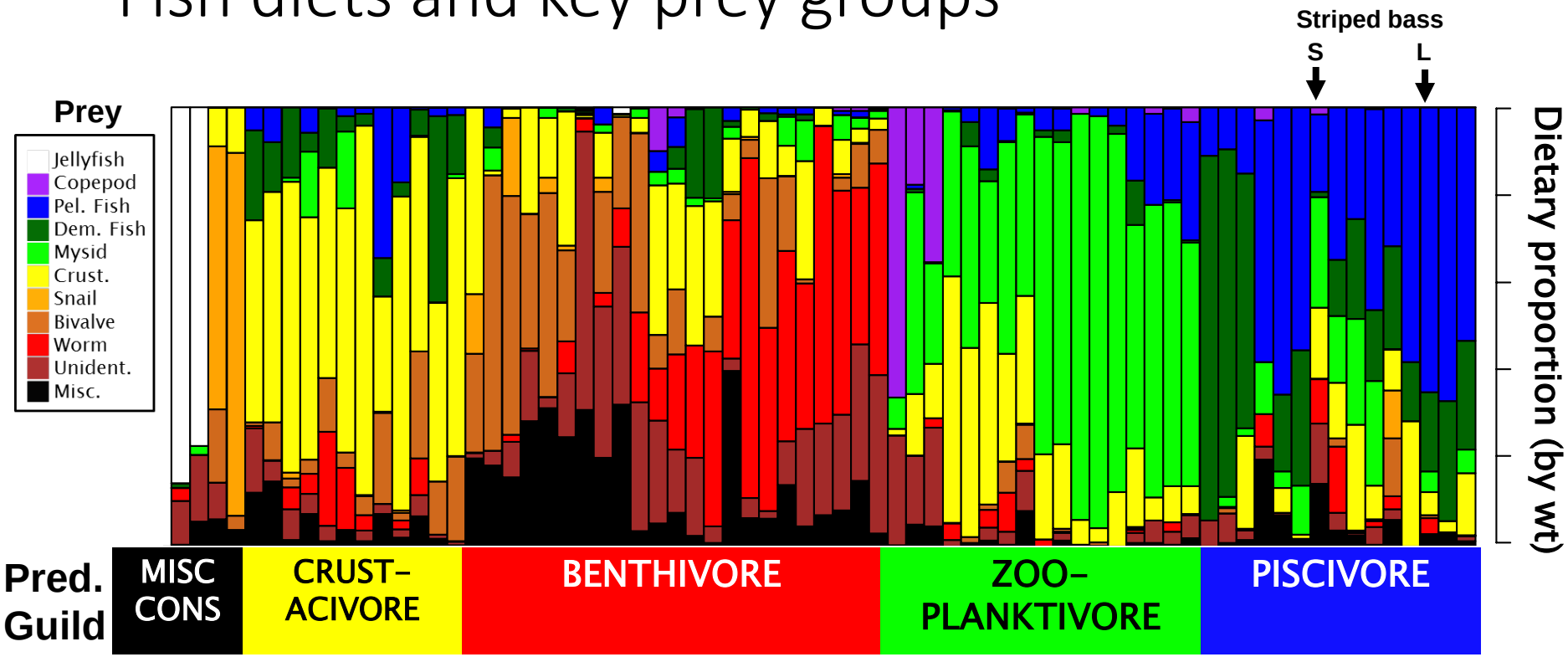
Project Objectives

1. Develop a suite of forage indicators of key prey species in Chesapeake Bay
   - Track status of forage through time

2. Develop a nutritional profile for five dominant predatory fishes
   - Scaling consumption to bay-wide population
   - Compare effects of different predators on forage base and relative importance of prey (accounting for size and seasonal diet changes)



Fish diets and key prey groups

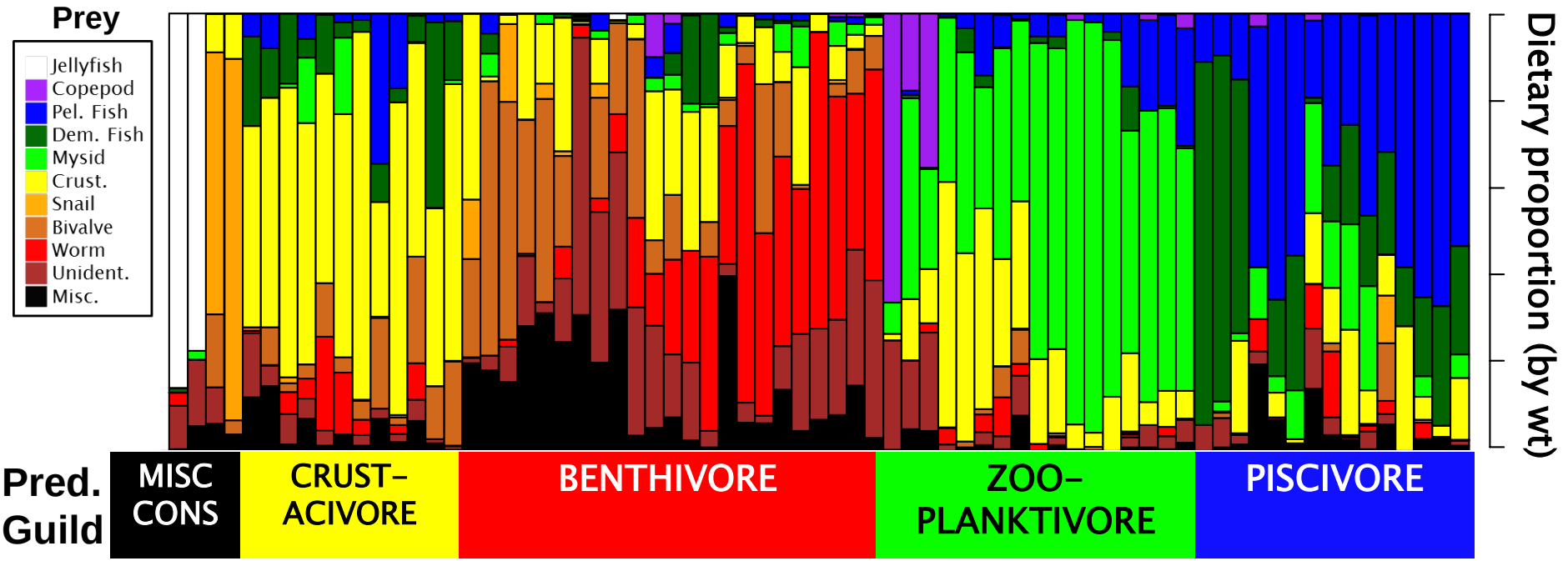


ChesMMAP Data

- 47 species, captured by trawl
- multiple size classes for some, yielding 71 predator groups
- Predator size range ~5-100cm
- >25,000 stomachs

Buchheister and Latour 2015

Fish diets and key prey groups



12 Key Prey Groups

Crustaceans
- Sand shrimp
- Mantis shrimp
- Blue crabs

Worms
- Polychaetes

Bivalves
- Razor clams
- *Macoma spp.*

Mysids
- *Neomysis americana*

Pelagic fishes
- Bay anchovy
- Menhaden

Demersal fishes
- Croaker
- Spot
- Weakfish

Buchheister and Latour 2015

Objective 1. Develop forage indicators

Forage indicator
1. Relative prey abundance
2. Diet-based indices
3. Predator-prey ratios
4. Consumption ratios

- Metrics identified in Forage Workshop
- Suites of indicators are more informative than a single metric*
  - ChesMMAP – case study for multiple indicator types

*Rice and Rochet 2005, Methratta and Link 2006

Data sources

- Surveys (using 9 of 33 available)
  - Criteria: 10+ years, mainstem or tributaries, reliable capture
- Represent various geographic areas and salinity regimes

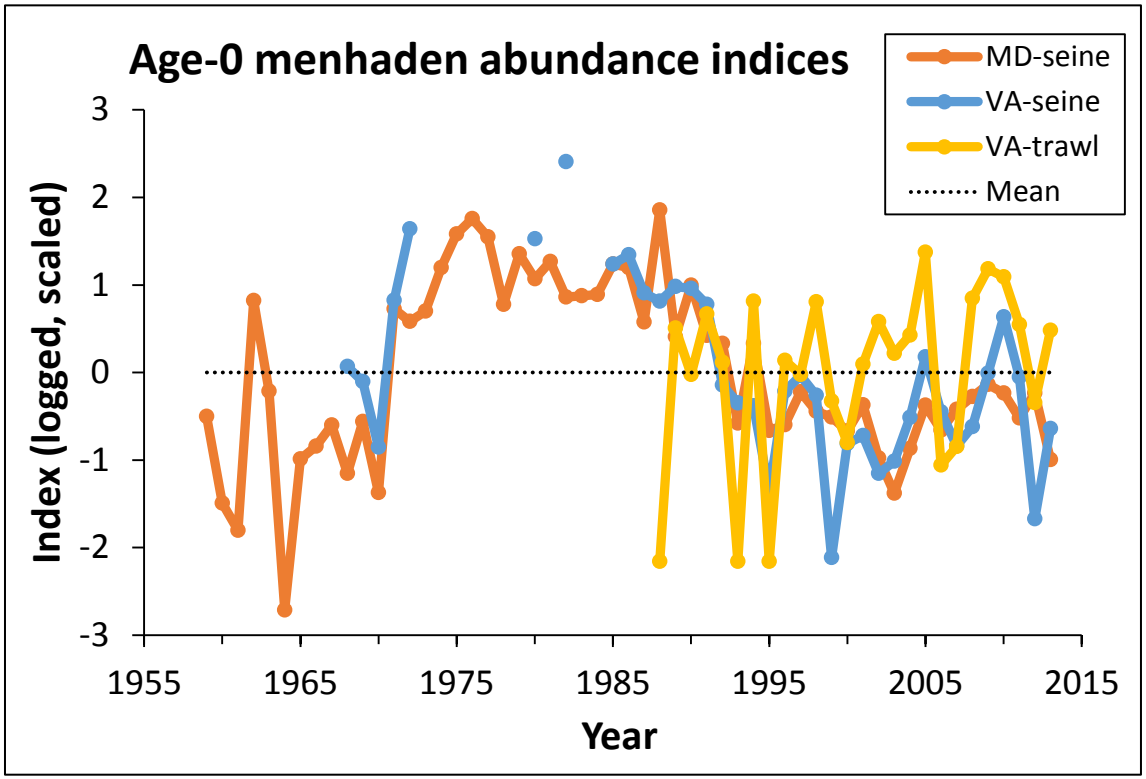
			Fishes					Crust.				Other																
	Title	Location	bay anchovy	menhaden	weakfish	spot	croaker	mysids	mantis	blue crab	sand shrimp	polychaetes	razorclam	Macoma	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	No. Years
1	MDDNR Seine	MD Tribs	1	1		1	1																				60
2	MDDNR Sum. Trawl	MD Tribs, bays	1	1	1	1	1																				38
3	PRFC Pound Net	Potomac Riv		1																							39
4	VIMS Juv Trawl	VA Tribs, mainstem	1	1	1	1	1			1																	26
5	VIMS Seine	VA Tribs	1	1	1	1	1																				48
6	Winter Dredge	Tribs, mainstem								1																	25
7	CBP Benthos	Tribs, mainstem										1	1	1													27
8	TIES/CHESFIMS	Mainstem	1	1	1	1	1																				13
9	ChesMMAP	Mainstem	2		3	3	3	2	2	1	2	2	2	2													13

Codes for Indicator Types

1 – Biomass/Abundance, 2 – Diet-based, 3 – All

Indicator 1: Relative prey abundance/biomass

- Survey-based estimates of relative prey abundance or biomass.
- Metric of prey standing stock in system over time.
- Principal forage indicator of interest.



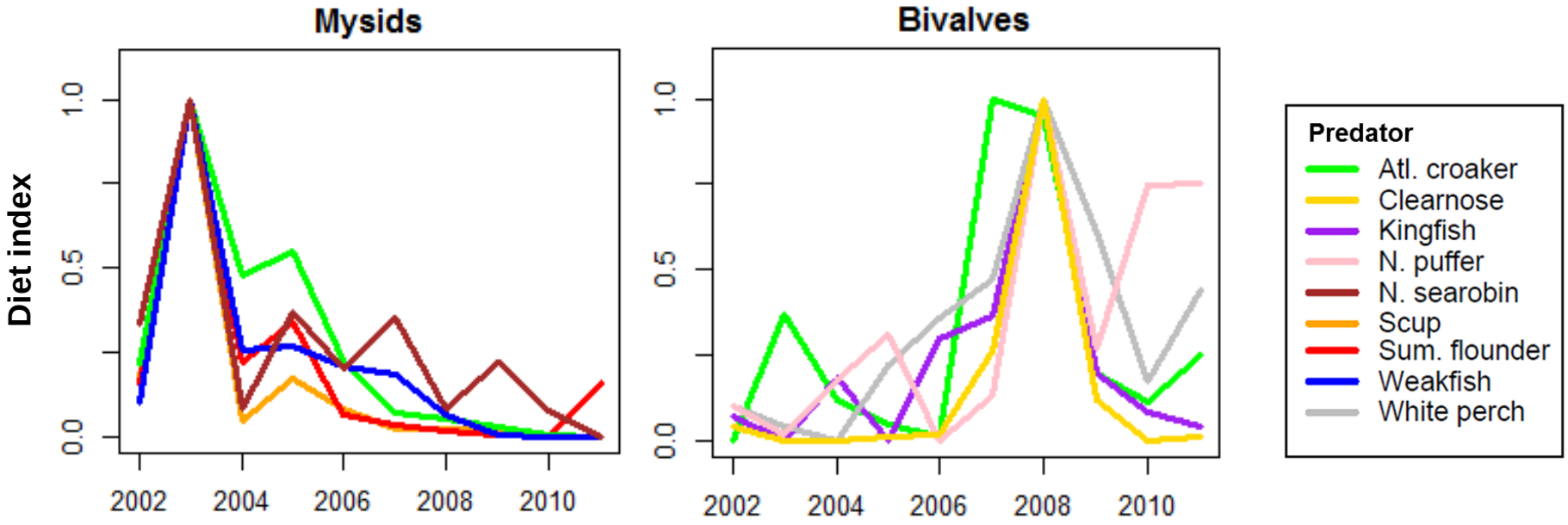
- Similar patterns across surveys
- Long-term trends
- Will develop a pooled index

Indices from menhaden stock assessment

Indicator 2: Diet-based indicators

- Use predators as prey “samplers”.
- Index of relative prey availability and importance.
- Particularly useful for poorly sampled prey (e.g., mysids, bivalves, sand shrimp, mantis shrimp).

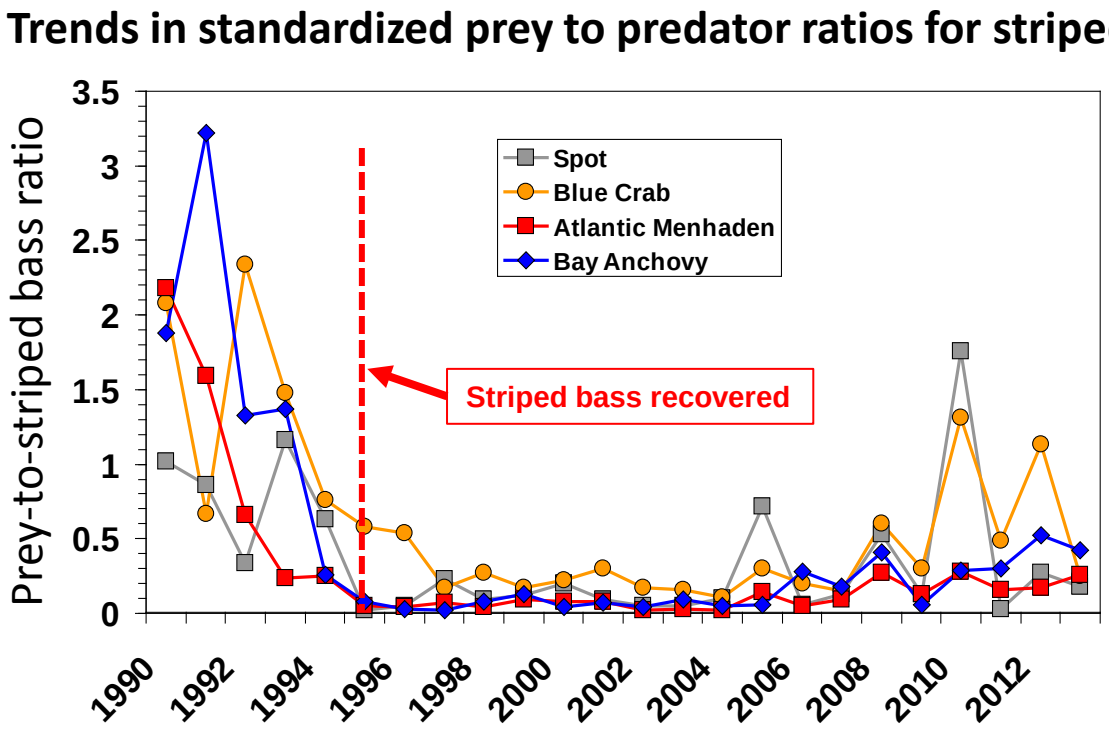
- Coherence across predators
- Indirect effects of changes?



Buchheister and Latour, in press

Indicator 3: Prey to predator ratios (PPR)

- Ratio of prey to predator indices ($\mathrm{PPR} = \frac{Prey\ Index}{Predator\ Index}$)
- Index of relative prey availability, accounting for predator density



Uphoff et al. 2015 – MD DNR Report

Indicator 4: Consumption ratios

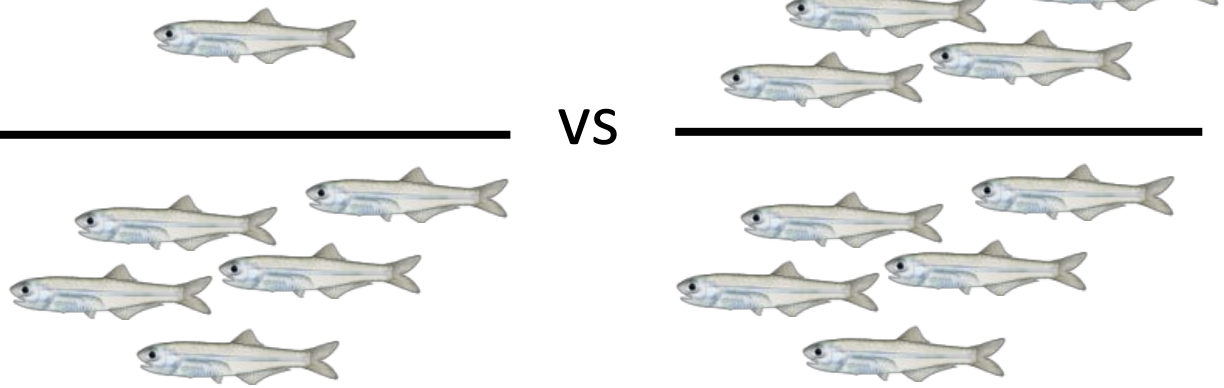
- Ratio of population-scaled consumption to prey biomass index

$$\mathrm{CR} = \frac{Total\ Prey\ Consumed}{Prey\ Index}$$

Will be calculated for Objective 2

- Index of predation intensity
- If prey index is a measure of total prey biomass, CR would be a measure of the fraction of standing stock biomass consumed

$$\frac{Prey\ consumed}{Prey\ index} = \frac{0.2}{\quad} \text{ vs } \frac{0.8}{\quad}$$

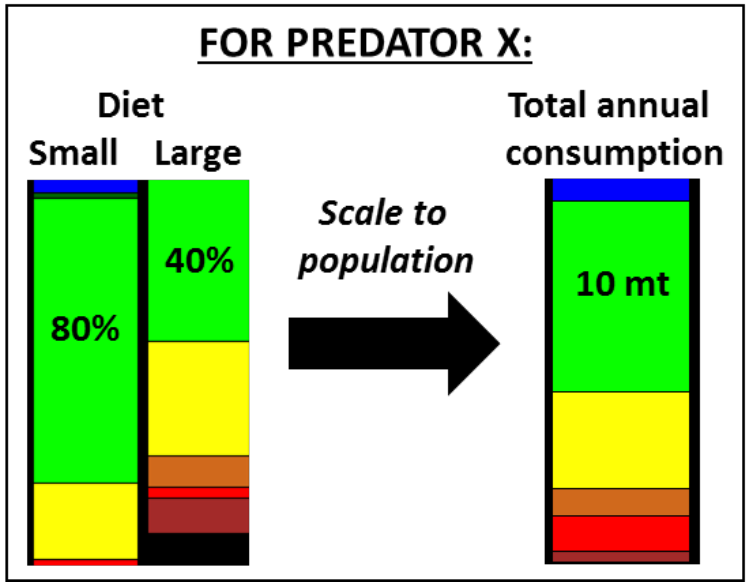


Integrating indicator information

- Merging indices for the same species
  - Hierarchical analytical method (Conn 2010)
  - Weighted average
- Indices for functional prey groups
  - Pelagic fish prey
  - Demersal fish prey
  - Benthic invertebrate prey
- Comparing across multiple indicators
  - ChesMMAP as a case study
  - What are the similarities and differences?

Objective 2 – Develop nutritional profile

- Calculate annual, bay-wide consumption of key prey by 5 dominant predators
- Seasonal & size-specific consumption estimates based on dietary changes (but constrained by available data).



Key Prey Groups

Pelagic fishes
- Bay anchovy
- menhaden

Demersal fishes
- Croaker
- Spot,
- Weakfish

Mysids

Worms

Bivalves

Crustaceans

Key Predators (75% of CM catch by wt[1])


White perch


Atlantic croaker


Striped bass


Spot


Summer flounder

[1]Buchheister et al. 2013

Objective 2 – Develop nutritional profile

- Calculate annual, bay-wide consumption of key prey by 5 dominant predators
- Seasonal & size-specific consumption estimates based on dietary changes

Annual consumption (C) = Per capita, daily consumption (c) X Predator abundance (N) X Time period (t) X Diet proportion (D)

Evacuation rate model ~f(fullness, temp)

Area-swept estimates

Gut contents

- Useful in comparing:
  - magnitude of predation across predators (ie, what predators have the largest effect?)
  - relative importance of different prey (account for size class & seasonal diet changes)
  - changes in consumption pressure from 2002-2014

E.g., Link and Sosebee 2008, Overholtz and Link 2007

Expected outcomes

- Obj. 1 – Time series of multiple forage indicators
  - Quantify the status of several key prey groups through time
  - Integrate information from multiple surveys
  - Basis for future development of target and threshold indicator values for adaptive fisheries management
- Obj. 2 – Nutritional profiles for five dominant predators
  - Quantify consumption of different key prey groups
  - Aid in developing forage indicators
  - Supply basic information on observed consumption patterns that managers can share with concerned stakeholders
- Status
  - Data (available indices & raw data) mostly compiled, calculating prey indices
  - Deadline of December, 2015

Acknowledgements

- Funding
  - Chesapeake Bay Trust and EPA
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